

<b>TEST PROCEDURE</b>		<b>TP 704E</b>
<b>Title</b>	<b>Page Number</b>	
Diurnal Heat Build No-Evap Test	1 of 13	
<b>Originator</b>	<b>Supersedes</b>	
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<b>Responsible Organization</b>	<b>Computer Program</b>	
Vehicle Testing (VT)	None Required	
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Form	Form 704-01	
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### Implementation Approval

Original Test Procedure Authorized by EPCN #110 on 06-08-92

### Revision Description

- (1) 09-30-94 The purpose of this change is to revise the procedure as described in EPCN #170.

**Note:** Specific brand names in EPA/EOD procedures are for reference only and are not an endorsement of those products.

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**1. Purpose**

The purpose of this procedure is to prepare a “no-evap” vehicle for the exhaust emission test by simulating a diurnal fuel temperature rise within a specified period of time.

**2. Test Article Description**

1978 and later model year gasoline-fueled light-duty vehicles that are not to be tested for evaporative emission

**3. References**

- 3.1 “Code of Federal Regulations,” Title 40, Part 86, Subpart A, and Section 86.082, and Subpart B, Sections 86.105, 86.106, 86.107, 86.113, 86.116, 86.127, 86.130, 86.131, 86.132, 86.133, and 86.142
- 3.2 Environmental Protection Agency (EPA) Laboratory Safety Manual
- 3.3 TP 702, Vehicle Fuel Exchange
- 3.4 American Society for Testing and Materials (ASTM) E29-67, “Standard Recommended Practice for Indicating Which Places of Figures are to be Considered Significant in Specified Limiting Values”
- 3.5 LFE temperature achiever operational procedure

**4. Required Equipment**

- 4.1 Form 704-01, Diurnal Heat Build-No Evap
- Form 702-01, Vehicle Fuel Exchange
- Form 708-01, Vehicle Test Data Sheet
- (1) Form 902-01, Test Status Report
- Vehicle Specification Report

- 4.2 Temperature recording system — strip chart recorder(s) or automatic data processor shall be used to record ambient and vehicle fuel tank temperatures during the test.

The temperature recorder or data processor shall record each temperature at least once every minute.

The recording system shall be capable of resolving time to  $\pm 15$ s and resolving temperature to  $\pm 0.75$  °F in the range of 0-62 minutes.

The temperature recording system (recorder and sensor) shall have an accuracy of  $\pm 3$  °F in the range of 55-90 °F.

The recorder (data processor) shall have a time accuracy of  $\pm 15$ s and a precision of  $\pm 15$ s in the range of 0-62 minutes.

Equipment used: Esterline Angus strip chart; Model L11245 multipoint; or Soltec strip chart, Model 3316, if the heat build is performed in the Sealed Housing for Evaporative Determination (SHED) with the door open.

- 4.3 Temperature sensors, thermocouples — Type “J” thermocouples, iron-constantan; 2 channels available for vehicle fuel tanks, 1 primary and 1 auxiliary fuel tank thermocouple, 1 thermocouple for monitoring ambient air.

If the test is performed in the SHED, use the ambient temperature monitoring system for the SHED.

Equipment used: Type “J” thermocouples; various manufacturers

- 4.4 Automatic temperature achiever — must be capable of controlling the fuel tank temperature during the diurnal heat build to within:

$\pm 3$  °F of  $60$  °F  $\pm 2$  °F + ( $24$  °F  $\pm 1$  °F) at  $60 \pm 2$  minutes of the following equation:

$$F = T_O + 0.4t$$

where: F = fuel temperature in °F  
 $T_O$  = initial fuel temperature  
 t = elapsed time, in minutes, from the start of the test.

Equipment used: Leeds & Northrup Electromax III System or LFE Corporation temperature achiever

- 4.5 Fuel tank heating device — must not cause hot spots on the tank wetted surface which could cause local overheating of the fuel.

Equipment used: Various size silicone rubber heat blankets supplied by William C. Fay Company, Orchard Lake, Michigan; and Conrad Company, Inc., Royal Oak, Michigan; or an alternative system supplied by the vehicle manufacturer.

- 4.6 Magnets or other related equipment for attaching the heat blanket to the vehicle fuel tank.

Equipment used: 3-1/2 inch magnets, or crank-style blanket

- 4.7 Barometer — A central laboratory barometer is used.

Equipment used: Mensor digital barometer

- 4.8 Digital clock set to master time clock and located at each work area.

Equipment used: Fabricated to meet our requirements

## 5. Precautions

- 5.1 Vehicle fueling safety precautions as outlined in Section 5 of Test Procedure 702, Vehicle Fuel Exchange, must be followed.

- 5.4 The operator must use the real-time monitor clock displayed in the soak area for recording the time the event occurred.

- 5.5 If the strip chart recorder power has been off for any period of time, an equal period of time with the recorder power on is required for instrument warm-up.

A 1-minute power off requires a 1-minute warm-up, etc., up to a 1-hour maximum warm-up.

If you are unable to determine how long the recorder has been off, you must allow for a 1-hour warm-up.

If you turn on a recorder, you must write down the “time on” on the chart.

- 5.6 The heating system must not cause hot spots on the tank wetted surface which could cause local overheating of the fuel.

5.7 For vehicles with multiple tanks, the largest tank shall be designated as the primary tank.

5.8 Paper towels used to wipe up fuel spills must be disposed of by placing them in the red containers located in the fuel bays.

These containers must not be used for non-contaminated waste.

## 6. Visual Inspection

All visual inspections are included as part of test article preparation and test procedure.

## 7. Test Article Preparation

It is the responsibility of the operator to ensure that the following steps are performed prior to the diurnal heat build test.

7.1 Following the vehicle preconditioning procedure, the test vehicle shall be allowed to soak for a period of not less than 12 nor more than 36 hours prior to the start of the exhaust emission test.

7.2 The diurnal test shall start not less than 10 nor more than 35 hours after the end of vehicle preconditioning (engine off).

Heat build should start at a time such that the 36-hour limit is not exceeded.

7.3 Check that strip chart recorders used for monitoring temperatures are working properly and the power has been on for at least 1 hour (see Step 5.5 for details), the Leeds & Northrup temperature achiever power has been on for at least 15 minutes, or the LFE Corporation achiever power has been on for a minimum of 3 minutes.

7.4 Record the date, test number, strip chart recorder equipment tracking ID number, vehicle manufacturer and identification number, chart speed, and the operator's identification number on the heat build strip chart.

Identify each channel used.

7.5 Using the magnets or the crank-style to secure the blanket to the tank, install the appropriate heat blanket.

## 8. Test Procedure

The technician is responsible for assuring that the following steps are performed during the diurnal heat build test.

As Steps 100 through 116 are completed, fill out the appropriate sections of Form 704-01 and the appropriate fuel container ID on Form 708-01.

The draining and fueling of the vehicle prior to the heat build test are described in TP 702.

- 100 Connect the recording system thermocouple lead(s) to the vehicle fuel tank thermocouple(s) lead(s).

Label each recorder channel being used to record temperatures with the corresponding channel number/color on the strip chart.

- 101 Start the temperature recorder by setting the speed to 2 cm/min. for Soltec (if using the SHED system) or 0.5 in/min. for the Esterline-Angus (on carts).

- 102 Reset the strip chart timer/event marker to zero.

- 103 Check that the fuel tank(s) temperature is below 62 °F.

If the fuel temperature is between 58-62 °F, install the fuel cap and activate the heat source, if necessary.

Begin the heat build, making sure the fuel temperature is below 62 °F.

If the fuel temperature is above 62 °F, notify supervisory personnel.

For vehicles with multiple fuel tanks, both tanks' fuel temperatures must be between 58-62 °F simultaneously before the fuel caps are replaced.

The auxiliary tank's fuel temperature must remain within  $\pm 3$  °F of the primary tank's fuel temperature at all times during the heat build.

Ideally, fuel temperatures should be the same at the start of the test.

- 104 Verify the operation of the heat blanket by feeling the heat blanket(s) for warmth. Refer to the LFE temperature achiever operational procedure for specific details.

- 105 If the fuel tank(s) temperature is below 58 °F, install the heat source if necessary.  
Place the temperature achiever in the manual mode and slowly raise the fuel temperature(s).
- 106 Record the heat source identification number in the “Comments” section of the Vehicle Test Data Sheet and on the strip chart.
- 107 As soon as the temperature of the fuel in the vehicle tank(s) reaches 58 °F, install the fuel tank cap(s) and mark the strip chart trace “gas cap(s) on.”  
  
Ideally, the fuel temperatures for multiple tanks should be the same at the start of the test. The equation in Step 110 applies to the primary tank.
- 108 As soon as the temperature of the fuel in the tank(s) reaches 60 °F, immediately start the event marker/timer, place the achiever in auto mode, and start the diurnal heat build.  
  
This commences the 60 ±2 minutes test period.  
  
Although a tolerance of ±2 °F of 60 °F is allowed for the starting temperature, it is desirable to begin the heat build at a fuel temperature of 60 °F.
- 109 Record the heat build start time on Form 704-01.
- 110 The fuel shall be heated in such a way that its temperature change conforms to the following function to within ±3 °F (±1.6 °C)  
  

$$F = T_0 + 0.4 t \text{ ( for SI units } C = T_0 + (2/9)t \text{ )}$$
where: F = fuel temperature, in °F  
C = fuel temperature, in °C  
T<sub>0</sub> = initial fuel temperature  
t = elapsed time, in minutes, from the start of the test.  
  
After 60 ±2 minutes of heating the fuel temperature rise shall be 24 ±1 °F (13.4 °C (±0.5 °C)).
- Note:** For vehicles with multiple tanks, the auxiliary tank shall undergo a similar heat build such that the fuel temperature shall be within 3 °F of the primary tank.
- 111 Use the equation  $T = T_0 + (0.4 \times t)$  to calculate the target fuel temperatures at t=15, 30, 45, and 60 minutes.

- 112 Record these values on Form 704-01.
- 113 At 15-minute intervals during the heat build ( $t = 0, 15, 30, 45$ , and end of diurnal), verify that the fuel tank(s) temperature(s) and the ambient temperature are within the target temperature tolerances.
- 114 When the temperature of the fuel within the primary tank has risen  $24\text{ }^{\circ}\text{F} \pm 1\text{ }^{\circ}\text{F}$  from the initial fuel temperature, the time constraint of  $t = 60 \pm 2$  minutes is met, and the auxiliary tank temperature is within  $3\text{ }^{\circ}\text{F}$  of the main tank fuel temperature, the heat build is complete.

On Form 704-01, record the completion time from the clock provided at the work area.

**Note:** Although a tolerance of  $\pm 2$  minutes is allowable, it is desirable to end the heat build at 60 minutes if possible.

If the end of the heat build is other than 60 minutes, the traces must be marked as such and a time entered on the strip chart corresponding to that end time.

- 115 Immediately upon completion of the heat build, turn off the fuel tank heat source and remove it from the test vehicle tank(s), if installed by EPA.
- 116 Disconnect any remaining equipment.

The test vehicle is now ready to be pushed, not driven, onto the dynamometer for the Urban Dyno Exhaust Emission Test (TP 707), which must start within 1 hour from the end of the diurnal heat build.

## 9. Data Input

- 9.1 Record on the strip chart the date, test number, chart speed, recorder equipment tracking ID number, heat source code number (or describe the heat source if supplied by manufacturer), vehicle identification number, and the operator's identification number.
- 9.2 Form 704-01 is completed as required.
- 9.3 The heat source identification number is recorded in the comments section of the Vehicle Test Data Sheet.
- 9.4 The fuel container ID code is recorded on the Vehicle Test Data Sheet.

**10. Data Analysis**

Forms 704-01 and 708-01 are kept with the vehicle until the completion of testing.

**11. Data Output**

- 11.1 All forms and test records are verified by a qualified technician who did not record the data.

The verifying technician checks the data for completeness, accuracy, and compliance with EPA regulations.

He/she will write his/her identification number and date in the “Verified By” area of the forms.

On the strip charts, the technician will write his/her identification number and “OK.”

This certifies that the data are accurate and complete.

- 11.2 Forms 704-01 and 708-01 are submitted to Data Control at the completion of the sample analysis (TP 708), along with all other documentation accumulated during testing for data processing.
- 11.3 Strip chart traces are checked to ensure that readings have been correctly identified and tolerances have been adhered to during the diurnal heat build.
- 11.4 Form 704-01 is reviewed for adherence to time tolerances.

**12. Acceptance Criteria**

These criteria must be met for the test to be valid:

- 12.1 The diurnal heat build (Step 208) shall start not less than 10 hours nor more than 35 hours after the end of the vehicle preconditioning procedure.  
[See CFR 86.133]
- 12.2 The test vehicle must be fueled to 40% of the nominal tank capacity.  
[See CFR 86.133]

- 12.3 The vehicle shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution. [See CFR 86.130]
- 12.4 Ambient temperature levels encountered by the test vehicle shall not be less than 68 °F nor more than 86 °F. [See CFR 86.130]
- 12.5 The temperature of the fuel prior to its delivery to the fuel tank shall be between 45-60 °F. [See CFR 86.133]
- 12.6 Fuel tank cap(s) are not installed until the start of the diurnal heat build. [See CFR 86.133]
- 12.7 The diurnal heat build begins when the temperature of the fuel within the test vehicle fuel tank(s) reaches 60 °F  $\pm$  2 °F. [See CFR 86.133]
- 12.8 The fuel temperature in the primary tank must rise a total of 24 °F  $\pm$  1 °F, over a period of 60  $\pm$  2 minutes.
- The fuel temperature in the primary tank must conform within  $\pm$  3 °F to the equation  $F = T_o + (0.4 \times t)$  during the heat build (refer to Step 110 for further clarification). [See CFR 86.133]
- 12.9 The fuel temperature in an auxiliary tank shall undergo a similar heat build such that the fuel temperature shall be within  $\pm$  3 °F of the fuel temperature in the primary tank during the heat build. [See CFR 86.133]
- 12.10 Observed values obtained shall use the ASTM E29-67 absolute method to determine conformance with test specifications.
- Thus, any deviation outside the specified limiting value signifies non-conformance with the specification.

### 13. Quality Provisions

These provisions are guidelines that ensure test data quality. Non-compliance does not necessarily invalidate tests.

Any deviations are reported to the appropriate supervisory personnel for further action.

- 13.1 The technician follows the sequence of steps on Form 704-01, recording data as needed.

13.2 Time/event marked strip charts are used to ensure compliance with the  $60 \pm 2$  minutes time constraint of the heat build.

13.3 When the strip chart recorder power has been off for any period of time, an equal period of time with the recorder power on is required for instrument warm-up.

A 1-minute power off requires a 1-minute warm-up, etc., up to a 1-hour maximum warm-up.

13.4 When the Leeds & Northrup temperature achiever power has been off for any period of time, an equal period of time with the achiever power on is required for instrument warm-up.

A 1-minute power off requires a 1-minute warm-up, etc., up to a 15-minute maximum warm-up.

The LFE Corporation temperature achiever requires a minimum of 3 minutes for warm-up.

13.5 The target fuel temperature for test fuel prior to delivery to the test vehicle is 45-53 °F.

13.6 The heat build should begin when the fuel temperature reaches 60 °F, if possible (a tolerance of  $\pm 2$  °F is allowed). [See CFR 86.133]

13.7 Delays, such as unexpected equipment problems, must be documented.

The documentation must show the time the delay began, the time the delay ended, and the reason for the delay.

Delays to perform other unrelated duties are not acceptable.

(1) 13.8 Variations from the procedure are documented on Form 902-01.

13.9 All clock times are taken from the calibrated digital clocks provided at each work area.

13.10 The technician's identification number must appear on all forms and test records, certifying that the data are accurate and complete.

## Diurnal Heat Build - No Evap

Vehicle ID # \_\_\_\_\_

Test Number \_\_\_\_\_

Reset the strip chart timer or event marker to zero and set the chart speed to 0.5 inches/min. for Esterline Angus recorder or 2 cm/min. for Soltec recorder.

If using the Soltec chart recorder, verify that the pens correspond as indicated below:

Red - Primary fuel temp.

Brown - Secondary fuel temp

Black - Ambient temp

Verify heat source is operational.

Record heat source identification number in Comment section of Form 708-01.

When fuel temperature(s) reaches 58° F, install fuel cap(s); mark chart "gas cap on."

When the primary fuel temperature reaches 60° F, start the chart recorder timer or event marker.

Record heat build start time: \_\_\_\_\_

Calculate the primary tank target temperatures for 15 min. intervals; enter the values in the chart below.

Use the formula,  $T = T_0 + (0.4 \times t)$  to calculate the values.

Where: T = Target temperature in °F

$T_0$  = Initial fuel temperature in °F

t = Elapsed time, in minutes, from start of test.

Elapsed Time	0 MIN.	15 MIN.	30 MIN.	45 MIN.	60 MIN. (±2 min)
Temp. Tolerance	60 ±2 °F	±3 °F	±3 °F	±3 °F	±1 °F
Target Temp.	_____ °F	_____ °F	_____ °F	_____ °F	_____ °F
	$T_0$	$T_0+6$	$T_0+12$	$T_0+18$	$T_0+24 \pm 1$

### Note:

The final temperature of the fuel rise must be  $24 \pm 1$  °F within  $60 \pm 2$  minutes.

The auxiliary fuel tank temperature must be within 3 °F of the primary tank during the heat build.

At the end of the heat build, immediately remove the heat source.

Record Heat Build completion time: \_\_\_\_\_

### Signatures

I have performed all steps in accordance with the requirements of Test Procedure 704.

Technician ID #: \_\_\_\_\_

Date: \_\_\_\_\_

The data entries are accurate and meet the requirements of Test Procedure 704.

Verified by: \_\_\_\_\_

Date: \_\_\_\_\_